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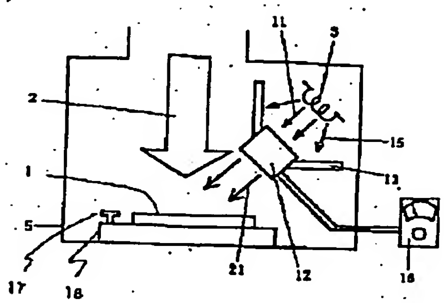
(54) CHARGE-UP PREVENTIVE DEVICE AND METHOD THEREOF

(57) Abstract:

PURPOSE: To effectively neutralize the charge-up of materials to be treated such as semiconductor generated by the radiation of an ion beam without the contamination of a heavy metaal and the increase in gas pressure involved.

CONSTITUTION: In an ion beam treatment chamber 5, a primary electron 11 discharged from a primary electron source 3 is incident upon an electron multiplier element 12 to undergo a multiplying effect and to make multiplied electrons 21 of several hundreds to several millions in amount in accordance with the multiplying rate, which are radiated to material 1 to be treated or an ion beam 2 to electrically neutralize them. At that time, heavy metal particles 15 discharged together with the primary electron 11 from the primary electron source 3 are shielded by a shielding material 13, so that they do not reach the materials 1 to be treated, and also since the electron multiplying element 12 does not require any operating gas and the like, the degree of vacuum in the vicinity of the materials to be treated is not deteriorated. Thereby, the heavy metal contamination and the deterioration of the degree of vacuum within the ion beam treatment chamber are not brought about and the charge-up of the materials to be treated can be effectively prevented.



[JP,06-267493,A]
* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] It is the charge-up arrester which prevents the charge up of the processed material concerned generated in case an ion beam is irradiated to the processed material which is equipped with the following and characterized by arranging the electronic multiplication element concerned so that the multiplication electron generated from it may be irradiated at either [at least] the aforementioned processed material or an ion beam by irradiating the electron for neutralization. The source of the primary electron The electronic multiplication element which carries out multiplication of the primary electron generated from the source of the primary electron concerned
[Claim 2] The charge-up arrester characterized by installing two or more aforementioned sources of the primary electron, and electronic multiplication elements near the processed material in a claim 1.
[Claim 3] The charge-up arrester characterized by having further the control means which control the amount of the aforementioned multiplication electron in claims 1 or 2.
[Claim 4] It is the charge-up arrester characterized by being at least one side of the multiplication factor control means which control the electronic multiplication factor of the primary-electron control means by which the aforementioned control means control the aforementioned primary-electron yield in a claim 3, and a multiplication element.
[Claim 5] The charge-up arrester characterized by irradiating only the electron which was further equipped with a transfer-between-orbit means to change the orbit of the aforementioned multiplication electron which moves near the processed material in either of the claims 1-4, and had specific energy on the processed material front face concerned.
[Claim 6] It is the charge-up arrester characterized by being a means to impress the magnetic field of the intensity which defined the aforementioned transfer-between-orbit means beforehand in the claim 5, and a direction.
[Claim 7] The charge-up arrester characterized by using the light source instead of the aforementioned source of the primary electron, and using a photoelectron multiplication element instead of the aforementioned electronic multiplication element in either of the claims 1-6.
[Claim 8] The charge-up arrester characterized by installing the aforementioned light source in the outside of a vacuum chamber in which the aforementioned photoelectron multiplication element is installed in a claim 7.
[Claim 9] The charge-up arrester characterized by using luminescence from the aforementioned ion beam as the aforementioned light source in a claim 7.
[Claim 10] The charge-up prevention method which carries out multiplication of the

primary electron generated from the source of the primary electron by the electronic multiplication element in the charge-up prevention method of preventing the charge up of the processed material concerned generated in case an ion beam is irradiated to a processed material by irradiating the electron for neutralization, and is characterized by preventing the charge up of ******** by irradiating the multiplication electron concerned to either [at least] a processed material or an ion beam, and neutralizing.
[Claim 11] The charge-up prevention method characterized by using the light source instead of the aforementioned source of the primary electron, and using a photoelectron multiplication element instead of the aforementioned electronic multiplication element in a claim 10.
[Claim 12] The ion beam processor characterized by having the aforementioned charge-up arrester in either of the claims 1-9 in the ion beam processor which has a processing room containing the ion source which pulls out ion by the energy which generated ion and was defined beforehand, a mass separation means to sort out only a certain specific ion in the ion beam from this ion source, and the processed material which irradiates the separated ion beam.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention is concerned with the ion beam processor aiming at performing semiconductor manufacture, the surface treatment of material, or membrane formation by the ion beam or plasma, and relates to the structure and the method of a charge-up arrester for preventing the charge up of a processed material.
[0002]
[Description of the Prior Art] In an ion beam processor, in case an ion beam is irradiated at a processed material, when a processed material is the insulating matter electrically, the positive charge of an ion beam is accumulated, and since the secondary electron at the time of ion beam irradiation occurs, a processed material is further charged in positive charge. This is called charge up. When this charge up progresses, electric discharge may take place between the interior of a processed material, or a grounding potential portion, and it may lead to destruction of a processed material. Therefore, prevention of a charge up was a technical problem important when raising the productivity of an ion beam processor.
[0003] The thing of the simplest structure among the conventional charge-up arresters was the method of irradiating a thermoelectron from filaments for thermionic emission, such as a tungsten, at an ion beam or a processed material. Moreover, recently, the plasma of inert gas is generated, an electron etc. is pulled out out of plasma, and the neutralization equipment which irradiates an ion beam is used.

[0004] In addition, as a well-known example about the above-mentioned conventional technology, there are JP,2-288143,A and JP,3-25846,A, for example.
[0005]
[Problem(s) to be Solved by the Invention] However, since heavy metal, such as a tungsten which is filament material, was irradiated by the processed material with an ion beam and caused the contamination by the method which used the filament, to processing of a semiconductor etc., it was unsuitable. Moreover, although the amount of neutralization electrons could be supplied enough and heavy metal contamination was not caused by the method using plasma, either, there was a problem that the gas pressure near the processed material became high, and control of the amount of neutralization electrons became difficult for the gas for plasma generating.
[0006] In pouring of the ion beam to a semiconductor, or the ion beam irradiation to a processed material like ion beam etching, without being accompanied by elevation of heavy metal contamination or gas pressure, the purpose of this invention is controlling the amount of neutralization electrons, and is to offer the method and charge-up arrester which prevent the charge up of a processed material proper, and offer the ion beam processor further equipped with the charge-up arrester.
[0007]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, according to one mode of this invention, a charge-up arrester with the source of the primary electron with the control means which generate a proper quantity of the electron for neutralization, the electronic multiplication element, or the light source and a photoelectron multiplication element is offered.
[0008] Moreover, according to other modes of this invention, the ion beam processor equipped with this charge-up arrester is offered.
[0009] Here, luminescence from an ion beam can also be used as the light source. Moreover, the specific magnetic field between a multiplication element, a processed material, or an ion beam can be impressed, and means to irradiate directly the electron of specific energy sorted out by this magnetic field or the electron generated by the multiplication electron at a processed material or an ion beam can also be taken.
[0010]
[Function] Incidence of the primary electron generated from the source of the primary electron is carried out to an electronic multiplication element, and multiplication is carried out to one 10,000 times the number [hundreds -] of this according to the multiplication factor of a multiplication element. A multiplication electron is irradiated by a processed material or ion beams, such as a semiconductor, neutralizes them electrically, and prevents the charge up of a processed material. At this time, the heavy-metal particle generated from the source of the primary electron can prevent the heavy metal contamination of a processed material by arranging the source of the primary electron so that a processed material may not irradiate.
[0011] Moreover, when a photoelectron multiplication element is used as a multiplication element, the photon emitted from the light source can carry out incidence to a photoelectron multiplication element, and can prevent a charge up by the multiplication electron generated from a photoelectron multiplication element in that case. This method can reduce the possibility of heavy metal contamination further rather than the above-mentioned case.
[0012] Furthermore, operation in an ultra-high vacuum is possible for a multiplication element and a photoelectron multiplication element, and since gas of operation is not needed like a plasma method, elevation of the gas pressure near the processed material can be prevented.
[0013]

[Example] Hereafter, one example of this invention is explained using drawing 1 , and 2 and 3. First, the whole ion beam injector composition used for manufacture of a semiconductor device at drawing 2 is shown.
[0014] In drawing 2 , the ion source which has the drawer electrode to which 6 ionizes a certain specific gas with microwave etc., and 7 are impressing the magnetic field generated with the coil, and the mass separation section which changes the orbit of ion, and 8 are the processing rooms holding processed materials, such as a semiconductor wafer which irradiates an ion beam. From the ion source 6, mass separation of the ion beam (not shown) pulled out by a certain specific extraction voltage is carried out in the mass separation section 7, only required ion is introduced at the processing room 5, and ion beam irradiation, an ion implantation, etc. to a processed material are performed there. 7
[0015] Next, the schematic diagram inside [which was shown in drawing 2 / processing room 5] an ion beam injector is shown in drawing 1 . drawing 1 -- setting -- 1 -- a processed material and 2 -- an ion beam and 3 -- the source of the primary electron, and 15 -- for a shelter and 16, as for the amount detector of charges, and 18, a multiplication element control unit and 17 are [the primary electron and 12 / an electronic multiplication element and 13 / a scanning base and 21] multiplication electrons
[0016] the primary electron 11 emitted from the source 3 (for example, filament for thermionic emission) of the primary electron -- the electronic multiplication element 12 (for example, micro channel plate) -- incidence -- carrying out -- there -- a multiplication operation -- receiving -- an electronic multiplication factor -- responding -- several 100- multiplication is increased tens of thousands times Control of an electronic multiplication factor is performed by controlling the voltage impressed to the electronic multiplication element 12.
[0017] Applied voltage and an electronic multiplication factor have the relation shown in drawing 3 , and can generate a processed material 1 or the multiplication electron 21 of a proper amount required for neutralization of an ion beam 2 according to the amount of charge-up charges of the processed material 1 detected by the amount detector 17 of charges, or the exposure of an ion beam 2 by controlling the multiplication factor control power source 16 of the electronic multiplication element 12.
[0018] Here, the beam diameter of an ion beam 2 is usually small compared with processed material 1 area. Therefore, a processed material 1 is fixed on the scanning base 18 which moves horizontally so that an ion beam 2 may be irradiated all over processed material 1. Moreover, the amount detector 17 of charges is also arranged on the scanning base 18 near it, and receives the same ion beam irradiation. The amount detector 17 of charges has a short piece with the same quality of the material as a processed material 1, and presumes the amount of charge-up charges of a processed material by measuring electric change produced when a beam is irradiated to it. Moreover, a beam can also be electrically scanned instead of using the scanning base 18.
[0019] The multiplication electron 21 emitted from the electronic multiplication element 12 is irradiated by a processed material 1 or the ion beam 2, and neutralizes them electrically. At this time, it can prevent the heavy-metal particles 15, such as the primary electron 11 emitted from the source 3 of the primary electron and a tungsten which constitutes a filament, carrying out incidence to a processed material 1 by forming a shelter 13 in between a processed material 1 and the sources 3 of the primary electron (i.e., the circumference of the electronic multiplication element 12).
[0020] Moreover, in this example, although it neutralized by controlling an electronic

multiplication factor, by controlling the supply voltage instead impressed to the source 3 of the primary electron, a primary-electron yield can be controlled or both can also be controlled further simultaneously.

[0021] Next, other examples of this invention are explained using drawing 4 .

[0022] Drawing 4 shows only the processing room 5 interior of the ion beam injector of drawing 2 . The feature of this example is the point using the light source 4 (for example, electric bulbs, such as a halogen lamp) as a source of the primary electron using the photoelectron multiplication element 14 which combined the photoelectric element and the electronic multiplication element instead of an electronic multiplication element, and other portions are the same as that of drawing 1 .

[0023] The photon 22 emitted from the light source 4 is changed into an electron by the photoelectron multiplication element 14, and multiplication is carried out. Therefore, since a heavy-metal particle is not generated, there is no danger of processed material 1 contamination. Moreover, the light source 4 currently installed in the processing room 5 is installed into the outside atmosphere of a processing room, and the same effect is acquired even if it irradiates a photon 22 through a translucency aperture at the photoelectron multiplication element 14.

[0024] Moreover, the amount of the redoubling electron 21 is also controllable by attaching the control unit for multiplication factor control in the photoelectron multiplication element 14, or controlling the supply power supply of the light source 4 like the example of drawing 1 , and controlling the quantity of light, or combining both the aforementioned control method.

[0025] Next, other examples of this invention are explained using drawing 5 .

[0026] Drawing 5 shows only the processing room 5 interior of the ion beam injector of drawing 2 . It is the point of the feature of this example having installed the electronic multiplication element 12 in a position and an angle at which the multiplication electron 21 emitted from the electronic multiplication element 12 is not directly irradiated by the processed material 1, and having impressed the magnetic field 31 near the processed material further, and other portions are the same as that of drawing 1 or drawing 4 .

[0027] In drawing 5 , if the magnetic field 31 of perpendicular facing down is impressed to space, the electrons 23 and 24 irradiated from the right-hand side in drawing will change the orbit toward a processed material 1 according to each energy. Therefore, only an electron with desired energy can be irradiated at a processed material 1 by adjusting moderately the intensity of a magnetic field 31, and the distance between the electronic multiplication element 12 and a processed material 1.

[0028] At this time, the damage of the processed material 1 by the high-energy multiplication electron 23 can be prevented by adjusting the intensity of a magnetic field 31 so that only the low energy multiplication electron 24 which had several eV energy among the multiplication electrons 23 and 24 which were able to change the orbit by the magnetic field 31 may be irradiated by processed material 1 front face.

[0029] Moreover, the amount of low energy electrons irradiated by the processed material 1 can be further increased by installing a secondary-electron-emission board in the position which the high-energy multiplication electron 23 irradiates. As a means to impress a magnetic field 31 to about one processed material, although a coil or a permanent magnet can also be used, a permanent magnet is used, and it is [way] simple and can install in both in a vacuum or the atmosphere. Moreover, it is also possible to use an electrostatic decelerating electrode etc. as a means which prevents the high-energy multiplication electron 23 carrying out incidence to a processed material 1.

[0030] As mentioned above, although explained using some examples, it is also

possible to also install two or more electronic multiplication elements in each example and to carry out combining each example.

[0031]

[Effect of the Invention] As explained above, while generating a lot of electrons for neutralization easily irrespective of the degree of vacuum of the processing interior of a room according to this invention, an exposure can be controlled, a processed material can be further protected from the damage and contamination by the high-energy electron, heavy metal, etc., and it is very useful on industry.

[0032]

[Translation done